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ABSTRACT

Force feedback in large, immersive environments is provided by device which a gyro- stabilization to generate a fixed point of leverage for the requisite forces and/or torques. In one embodiment, one or more orthogonally oriented rotating gyroscopes are used to provide a stable platform to which a force-reflecting device can be mounted, thereby coupling reaction forces to a user without the need for connection to a fixed frame. In one physical realization, a rigid handle or joystick is directly connected to the three-axis stabilized platform and using an inventive control scheme to modulate motor torques so that only the desired forces are felt. In an alternative embodiment, a reaction sphere is used to produce the requisite inertial stabilization. Since the sphere is capable of providing controlled torques about three arbitrary, linearly independent axes, it can be used in place of three reaction wheels to provide three-axis stabilization for a variety of space-based and terrestrial applications.

24 Claims, 14 Drawing Sheets